Cork – current and new materials

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Cork is the bark of the oak tree (Q. suber L.) which is periodically extracted from the tree, usually every nine to 12 years, depending on the region. The cork oak tree exists mainly in the Atlantic – Mediterranean region (Portugal, Spain, South of France, part of Italy and North of Africa). Portugal is the world major producer of cork. Europe has about 60% of the total production area (cork forests) and produces more than 80% of all the cork. Portugal is the world major cork producer and process about ¾ of all the cork.

Current Cork Materials

Cork processing is diversified and uses all types of cork raw materials. Different cork products for different applications are produced: cork stoppers, floor and wall coverings, thermal/acoustic/vibration insulators, gifts, memoboards, gaskets, etc., made either from natural or agglomerated cork. Cork products have a good durability. Most of the products can be recycled, reused and/or burned for energy production.

Agglomerated composition cork includes several cork agglomerates using different binders. Current cork composites already on the market are "rubbercork" and some "concrete-cork" materials. "Rubbercork" is a composite of cork and rubber, mainly used for joints (industry, construction, automobiles) and heavy duty floor coverings (buildings, transports) or even underlays. The rubber used depends on the foreseen application of the final product, for instance it should have oil resistance for engine joints

New Cork Materials

Our laboratory has developed new and patented utilizations and products based on cork, some of them already in the market: (Cork powder agglomerates without glues?1?; Agglomerates of cork particles and thermoplastic materials?2?; Cleaning/scouring of atmospheric polluted materials with cork residues?3?; Wood treatment products based on cork industry wastes?4?; Densified insulation corkboard?5?). New applications are also being developed namely for automobile interiors, and composites with plastics and vegetal materials and the activation of cork for rubbercork.

The first method is based on a chemical treatment of the cork material in order to use some of the chemical components of the cork cell wall as binding agents. The major cell wall compound is suberin which is a very large polymer and usually is inert. The process of this patent depolymerizes the suberin, and the obtained monomers work as adhesive agents when they polymerize during the agglutination process (pressure and heat). Rigid agglomerates are obtained.

The agglomerate of cork particles with thermoplastic binding agents was developed to use mostly cork powder, the major industrial cork waste. Low melting index thermoplastics were chosen due to their advantages over conventional glues, namely the absence of solvents and non toxicity. In the case of some thermoplastics, e.g. polyethylene, the gluing of suitable surface covering sheets is possible in one single agglomeration operation. These new composites are stiff and hard and not resilient unlike common cork agglomerates.

One of the works relates to a process for scouring/cleaning/removing dirt and deposits from materials exposed to environmental pollution, in which very abrasive products can not be used. The process is based in the projection of corkwaste («terras») particles using compressed air. This process is now being used in Portugal for scouring vitrified ceramic or glass electric insulators in high voltage lines. New applications are foreseen, for example in monuments and façades cleanings. "Terras"

composition is ideal because its harder parts remove the dirt, the fibrous part polish the surfaces and the waxy constituents give a surface water repellent treatment. The good dielectric behaviour of cork material allows the scouring of electric insulators in high voltage lines without service interruption.
In the production of insulation corkboard, the steam, which crosses the granules, extracts some resins, which condense at the exit pipes in the form of a solid substance ("tar"). "Tar" is a waxy dark brown substance, composed by waxes, tannins and phenols, and some of the individual compounds seem to have biological activity. The idea of this work was to use this "tar" for wood treatments, aiming at the improvement of wood dimensional stability, wood protection and wood colouring. "Tar" flocks or blocks were ground and dissolved in different organic solvents and were applied by different methods in wood pieces. These solutions can be applied by different methods in wood pieces and are low cost and easy to obtain. The use of these products and methods improve wood behaviour. Namely for pine wood they improved dimensional stability giving rise to lower water absorption and swelling.

The densification of ICB is performed by heating of the boards and hot pressing under pressure, temperature and time conditions such that irreversible densification is achieved. A smoother surface and ^{3}.better characteristics for new applications. For example, for a 25 mm thick ICB board, operational conditions were: heating temperature of 180ºC, during 40 minutes, a pressing temperature of 180-230 ºC, a pressing time of 5-10 minutes and a pressure of 0,1-0,3 MPa. In this case the final thickness of the densified board was 7,0-8,5 mm. Densification may reach a density of more than 800 kg/m.

The solutions proposed for cork applications in automobiles (e.g. the steering wheel and the gear knob produced with natural cork or its derivatives) present advantages in terms of thermal behaviour and hence in increased comfort. Additionally, other solutions such as interior panels and decorative elements that can contribute to introduce distinctive aesthetic characteristics to the vehicles' interior are foreseen.

Related with rubbercork, is the activation of cork, for a better interaction with rubber, improving the characteristics of the final product and perhaps allowing for new applications. Although not really a new cork composite this is a development of current rubbercork. This work was based on the treatment of cork surface and the addition of some chemicals.

The composites of cork and agro-industrial wastes were also studied for mixtures of cork powder and rice husk, barley straw, pine bark, wood chips and condensate of insulation corkboard production. In these composites the self-gluing capability of cork due to its chemical composition was exploited. Cork powder/other materials ratio ranged from 1:1 to 1:4 in volume. Hot pressing at temperatures above 100 ºC allowed the melting of waxy materials from cork and eventually from the other materials, which work as binding agents. The most interesting composites were cork powder-rice husk and cork powder-pine bark boards, especially when using also the "condensate" waste. The densities were around 800-900 kg/m^{3}. Applications for doors stuffing and some coverings are foreseen.

The composite solid films of hydroxypropylcelullose (HPC) and cork powder are a new class of materials. A specific cork powder of particles <50 ?m was used in different % w/w with HPC (0; 0,5; 1,0; 10,0) and in some cases (7%) with a diisocyanate. Some mechanical properties were determined.

References

?1? Portuguese Patent nº88239, issued 1994.08.04
?2? Portuguese Patent nº94133, issued 1998.02.19
?3? Portuguese Patent nº101915, issued 1999.10.25
?4? Portuguese Patent nº101927, issued 1999.10.25
?5? Portuguese Patent nº100647, issued 1999.09.17

?6? Gil, L. (1993). New cork powder particle boards with thermoplastic binding agents.Wood Science and Technology, Vol.27, p. 173-182.
?7? Gil, L. and Duarte, C. (1997). Biomass chemical wastes from the cork industry for wood tratments. Proceedings of the 3rd Biomass Conference of the Americas, Montreal Vol.2, p. 963-969.